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ment of the fish, as would give some idea of the practical parts of the art of pisciculture. There are many details connected with the subject which we have not touched upon. They can be found very thoroughly treated of in any of the modern works on pisciculture, of which Norris' "American Fish Culture" is the latest and most practical.

In the above all general considerations have been avoided. It would, perhaps, have been as well to have stated that the arguments in favor of artificial hatching of eggs is based on the small proportion of them that are hatched when deposited in a stream, by the fish following the course of nature, and the very large proportion when hatched by artificial arrangement. The many enemies of fish spawn (other fish, water insects, birds, rats, not to speak of sediment, freshets, ice, etc., etc.) reduce the number of the eggs sadly. It has been calculated by English pisciculturalists that not one salmon reaches the proper size for the table out of every thousand eggs deposited in the stream. As the salmon migrates to the sea when weighing only a few ounces, it would, however, be more subject to casualty than the trout.

THE FRESH-WATER AQUARIUM.

BY C. B. BRIGHAM.

(Continued from page 136.)

We have seen that the aquarium is to be distinguished from the common fish-globe by its self-supporting character. We have examined in a general way the philosophy of the aquarium and concluded that the rectangular tank was the most useful one to have. Let us now look for a situation for the tank before the specimens are placed within it. It is desirable that the sun should shine upon the tank for at least an hour during the day; an eastern or southern aspect then is the best for this purpose. This is especially true in the winter time, while in summer a northern aspect would be preferred, as the water in the aquarium is apt to be overheated by the sun during the hot months. One trouble which arises from too much sun is this: that the small green plants of conferva grow very rapidly upon the glass and stones, obstructing the view of the inside of the tank, and rendering the stones very hard to clean when taken out. These confervæ do not injure the water at all; they even give out oxygen as other plants, and it seems as if it were a provision of nature, that they should render the glass opaque so as to protect the inmates of the tank from injury. This confervoid growth is not essential to the welfare of the tank if it is properly stocked with other plants, and it is desirable to have as little as possible of it. To effect this, a wide screen, or a simple sheet of brown paper, so placed as to shut out the sunlight from the tank will answer the purpose; or by pulling the window shade down when the sun shines upon the tank; or, what is best, by placing a row of plants with full foliage between the tank and the window, we have other means of obviating the difficulty.

Whether the sun shines upon the tank or not, a fresh-water aquarium should have all the daylight it can get, both for its own welfare and for our own convenience in examination. I am convinced that this is correct from my own experience, although Mr. Hibberd, a good authority on aquarial matters, says to the contrary: "A full flood of daylight is more harm than good, a frequency of sunshine destructive, and the tenants of an aquarium are seen to better advantage in a vessel lighted from above only." Before any specimens are introduced into the tank, it should be thoroughly washed out and the glass cleaned on all sides, as this is the only time when it can be done to advantage. We are sure then that no impurity of any kind will thus far hinder the success of the aquarium. The tank then is ready for the rock-work. This rock-work is useful: first, as a shelter for the animals, some of them being averse to the light if it is strong; second, as a means of concealing the sediment which, without doing any material injury, so mars the beauty of an aquarium; third, as a means for anchoring in their proper place the plants we put in; fourth, and lastly, to make the effect of the aquarium more like nature.

It is generally thought that most water-plants, to do well in an aquarium, must have soil to grow in as well as land-plants, and that a layer of earth or sand must be spread over the bottom of the tank for the roots; this is found by experience to be a mistake. No earth nor sand is required for the plants which grow best in the aquarium. Either is very apt to spoil the water after remaining in contact with it a short time. Coarse sand is, to be sure, sometimes used when we have animals in the tank whose nature it is to burrow, but even then only in a small quantity placed near a corner of the tank. Some of the small lilies grow better if they have a cubic inch of peat attached to their roots. This small quantity does not injure the water, however long it may remain in it, and is often very useful. In general, however, if the plants are placed right side up, among small stones about the size of a fresh pea, they will grow to any extent, seldom throwing out roots of any kind.

We want, then, a layer of small stones on the bottom, about an inch in thickness; this will be sufficient to bury the ends of the plants in, and to conceal all the sediment which may collect, at the same time giving depth enough for the mussels to burrow in. The stones used with tar for the tops of houses are about the right size for this layer, and on the top of it some larger stones about the size of an almond may be scattered here and there. As to the color of the stones this may add greatly to the effect. If we can have the patience to pick out for ourselves the white and variegated stones from the beaches, we shall be amply repaid by their appearance in water. White stones give a brighter look to the inside of the tank than dark-colored ones, and they show off the green plants much better; but they also show the green confervoid growths growing upon them much sooner than dark stones, and are much harder to clean after they have once become green. This difficulty of cleaning can be remedied by having two sets of stones, one being buried in damp sand while the other is in use. Were the beautiful stones of almost fabulous brilliancy which cover the San Mateo beach, near San Francisco, as common on our shores, we should have a famous groundwork for the aquarium. After the layer of small stones has been evenly spread upon the bottom of the tank, we may arrange the rock-work in the centre in the following way, which seems to be a good one, because by it we avoid using cement, which makes a tank look altogether too artificial, and we get a strong piece of work giving sufficient shelter to the animals, and one that will not be likely to fall down and injure the glass of the tank. It consists, essentially, of a series of three stone bridges, the one above being smaller than the one below. If the tank is small one or two bridges may be all sufficient. We take then two or more pieces of stone, having very rough edges so as to look more natural, and place them about a foot apart if the tank will admit of such a width, making a height of about two inches. Upon the tops of these pillars of support we place a thin flat stone, large enough to rest firmly on them, and even lap over an inch or so on each side; then upon this flat stone we place the pillars of another bridge, having the next flat stone somewhat smaller than the other, and so on until we have made so many bridges that the top one will just rest upon the surface of the water. The distance between these flat stones may vary according to the fancy of the builder. The top stone makes a little island, and gives a chance for such animals as tritons and turtles to come out and sun themselves or take the air. Another use which this top stone may be put to is this,—to support a small collection of marsh plants, making a great ornament to the aquarium.

Many of the fern-like mosses found growing on the rocks in damp places in the woods, or the swamp cowslips or violets, or the delicate plants of sundew (*Drosera rotundifolia*), or some of the kinds of arrowheads (*Sagittaria*), do perfectly well if planted in a very small quantity of soil upon this top stone. Our native pitcher plant (*Sarracenia purpurea*), and the red cardinal plant (*Lobelia cardinalis*), seem especially adapted for this purpose. If we take the former plant up in the fall and keep it growing upon the top stone until March, it will then begin to throw out its buds, and, before long, blossom most curiously. The latter plant seems to do best when taken up with the buds just appearing, and it will last long enough in flower to repay one for all the trouble of transplanting it. Various other means of beautifying the top stone may be adopted. If we wish a small collection of tropical ferns, and have room enough, we may cover them with a glass shade and have a diminutive Wardian-case, forming a part of the aquarium.

It is the custom with many to make a mound of marine-shells, or of coral, in the centre of the tank; besides being dangerous to the water from the difficulty of getting them perfectly clean, they seem quite out of place, not only because they are foreign to fresh water, but because it seems that the aquarium should be a place for living, not for dead specimens. It is far better to avoid putting in any shells, however beautiful they may be in the cabinet. Having completed the rock-work, and washed every stone carefully as it is put in, the plants are next to be attended to. In fresh-water plants we have for the most part to deal with the different shades of green, while in salt-water plants the colors are varied and brilliant. There is, however, this advantage in fresh-water plants, that almost all of them will grow well in a properly managed aquarium, while only the very green ones of the salt-water plants are likely to flourish under the same conditions. One great drawback to the growth of aquarial plants is the change of the water from a higher to a lower temperature, or the reverse. It is also sometimes found difficult to grow several kinds in one tank successfully. The common water-cress (*Nasturtium officinale*), for example, found mostly in cold springs and their brooks, will do well with water starwort (*Callitriche verna*), a plant growing in a similar situation, if the water in the tank is kept at a low temperature; but at a moderately high one grows long and rank, and finally decays. So again many plants which grow in brooks or rivers, and have become accustomed to be constantly moved by a current, when placed in the still water of an aquarium inevitably mould away.—*To be continued.*

REVIEWS

THE BUTTERFLIES OF NEW ENGLAND.—The notice in our last number of Mr. Scudder's promised work on New England Butterflies, has already brought many welcome responses. A number of living butterflies have been sent in cotton wool, and although a day upon their journey, were received alive and in good condition; those who live near Boston might try this method, but we think that most persons would be interested in raising the larvæ themselves. In attempting to obtain eggs for this purpose, it is better not to select the freshest butterflies, as their eggs will often prove undeveloped, or at least unimpregnated. It should also be remembered that the males usually appear about a week before the females, and experiments would therefore be more likely to succeed if made about a fortnight after the species is first observed. The following butterflies can be experimented upon by the time these lines meet the reader's eye:—*Pieris oleracea, rapæ* and *Protodice; Colias Philodice; Anthocaris Genutia; Chrysophanus Americanus; Lycæna Lucia* and *Comyntas; Thecla Auburniana, Niphon, Augustus* and *Henrici; Argynnis Bellona; Pyrameis cardui, Huntera* and *Atalanta; Vanessa Milberti* and *interrogationis*, and *Hesperia Massasoit, Quadaquina, Pocahontas, Metea* and others. The following species, the earlier stages of which are unknown, probably feed on the plants specified:—*Anthocaris Genutia* on cruciferous plants; *Lycæna Lucia* on buckthorn; *Thecla Auburniana* on smilax; *T. Niphon* on pine; *T. Augustus* and *Henrici* on vaccinium; *Argynnis Bellona* on violets or raspberry; and the different species of *Hesperia* on poplar, scrub oak, clover, grasses and various herbaceous plants.